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Influence of Postharvest Treatment of Oxalic Acid on Shelf Life and Quality of Litchi Fruit cv. Muzaffarpur

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Abstract— *A lab experiment was conducted in central laboratory of AFU, Rampur, Chitwan, Nepal, in first week of June in 2015 to assess the influence of acid on the pericarp browning and other keeping quality of litchi fruits after harvest. The experiment was carried out in Completely Randomized Design comprising five treatments; control, distilled water dipping for 5 minutes, oxalic acid @ 1%, oxalic acid @ 3% and oxalic acid @ 5% with four replications. The fruits treated with oxalic acid @ 5% retained more acceptable colour than those on other treatments. The cumulative physiological loss in weight (PLW) was minimum (9.15 %) with oxalic acid @ 5% treated fruits. Also, minimum spoilage loss of 13.9 % was found in the treatment oxalic acid @ 5% as compare to control. Thus, oxalic acid @ 5% was observed promising to improve the shelf life of litchi fruits after harvest so that fruits could be kept in better condition for about 10 days.*

Keywords—Litchi chinensis, postharvest quality, pericarp browning, oxalic acid.

I. INTRODUCTION

Litchi (*Litchi chinensis Sonn*) is tropical fruit. It is native to China (Nacif *et al*., 2001). It belongs to the family Sapindaceae. Litchi production has become one of the commercializing sectors in fruit industry in Nepal. It is grown mostly in Terai and inner Terai region followed by foothills of mahabharat range (FDD, 2008). In Nepal, total area and production of litchi in 2003 was 3,587.6 ha and 15,859 MT while it have been increased to 8048.17 ha and 36223.44 MT respectively with productivity of 7.20 MT per ha in 2014 (Table 1). In Nepal, 19 districts have been prioritized as potential litchi production area (FDD, 2008). Central development region has highest area under litchi production followed by western, eastern, mid-western and far western development region of Nepal. Seedless, Muzaffarpur, Calcuttia, Early large Red, Late large Red, Mclean, Rose-scented, Dehradun, are mostly cultivated cultivar in Nepal (Shrestha, 1996; Thapa & Karmacharya, 2001).

Table.1: Status of litchi production in Nepal

Region	Area (ha)	Productive area (ha)	Production (MT)	Productivity (MT/ha)
EDR	2915.6	1084	8435.5	7.78
CDR	2766.32	2123	16448.5	7.75
WDR	691.25	1253.45	7641	6.10
MWDR	497.5	423.3	1992.2	4.71
FWDR	177.5	145	1706.24	11.74
Total	8048.17	5028.75	36223.44	7.20

Source: MoAD, 2014

Life processes such as biochemical changes, transpiration and respiration are continuous in fruits even after harvest. The appearance and quality of the fruits goes on degrading after harvest during packing, transportation and storage. During this period, continue weight loss of litchi fruit occurs due to respiration, transpiration and evaporation from the fruit which is known as physiological loss in weight (Paul & Pandey, 2014). Pericarp browning is a major limitation to the retention of color due to moisture loss, which deteriorates fruit rapidly after harvest, often within 48 to 72 hours (Huang & Scott, 1985). Being highly perishable fruit, it cannot be stored for longer period of time in ordinary condition (Budhathoki, 2004).

Browning reduces the commercial value in market even though it may not influence the eating quality of the fruit (Snowden, 1990). In Nepal, skin of fruits discolored due to long distance transportation and delayed in retailing from the production sites to consumers table. Also, there is huge demand of the fruit in offseason as well.

Postharvest losses of most of the perishable fruit crops is 40-50% in developing countries due to high rate of brushing, water loss and decay during post harvest handling (Ray & Ravi, 2005). The major cause of postharvest loss in fruit is due to rotting (51%), mechanical damage (22%) and physiological weight loss (27%) (Devkota *et al*., 2014).

Litchi fruit is even more liable to this loss. Availability of fruit using postharvest loss reduction technology is better alternative than to increase production area and import from other countries. So, it is necessary to extend the shelf life, improve the storage quality and protect fruits from undesired quality for expanding consumer's demand for longer period using appropriate postharvest management technology (Pandit, 2007). However, it Nepal, the postharvest study in litchi is limited and there is no recommended practice for extension of shelf life and increasing quality The present study was therefore, carried out, taking into account the above mentioned facts to retain quality of litchi fruit.

II. MATERIALS AND METHODS

The experiment was conducted at Central Laboratory, Agriculture and Forestry University Rampur, Chitwan in the first week of June 2015. Geographically, the site is located at 27º 40' N Latitude and 84º 19' E Longitude at an altitude of 228 masl. Experiment was laid out in completely randomized design consisting of 5 treatments and four replications. The treatment was applied in Muzaffarpur variety of litchi. The details of treatment were as given below:

Treatments	Treatment combination
T_1	Control
T_2	Distilled water dipping
T_3	Oxalic acid @ 1%
T_4	Oxalic acid @ 3%
T_5	Oxalic acid @ 5%

Fruits with long stalks in clusters were destalked and sorted for uniform size, optimum maturity and fruit colour. Required amount of oxalic acid was measured to make the said concentration using distilled water. Selected fruit were dipped in these chemicals for five minutes as per the defined treatments using muslin cloth. All fruits of every experimental unit (50 in number of uniform size and quality) were kept in a perforated plastic tray separately after air dried in room condition. The analysis and observation was done inside the room under ordinary room condition for treated fruit. During the research period, the average temperature was 30± 5°C.

Observations on physiological characteristics like physiological loss in weight (PLW), pericarp browning and spoilage loss were recorded periodically on 2nd, 4th, 6th, 8th and 10th day of storage. The collected data were arranged in MS-Excel and statistically analyzed with the help of R STAT. Mean separation was done by DMRT at 5% level of significance (Gomez & Gomez, 1984).

III. RESULTS AND DISCUSSION

The present investigation was conducted to study physiological changes in the litchi fruits treated with different post harvest treatments during storage conditions. An attempt has been made to optimize the post harvest treatments for shelf life extension, maintaining quality and control of pericarp browning in fresh litchi fruits during storage.

Change in peel colour

The influence of postharvest treatments on skin colour of litchi fruit is presented in Table 2. The data showed the significant influence of treatments on skin color from day 2 to 10. The progressive decrease in red skin colour was noticed with increasing storage period resulting in increase in browning index. On the second day of storage higher colour rating of skin (4.32) was noted with control treatment followed by oxalic acid @ 1% (4.05) and lower colour rating of skin (3.18) was noted with oxalic acid @ 5%. Similar pattern of browning index was observed up to the last days of storage.

On the basis of above observations, it is clearly indicated that oxalic acid @ 5% treatment was better than other treatments to retain fresh fruit colour and minimizing browning of skin even up to 10th day after harvest. In the starting date of treatment, almost all the fruit sample had the colour rating of one which means that the fruits were bright red but as the fruits were kept in storage at room temperature condition for longer period the freshness of skin colour was loosened and the score obtained was maximum in later days.

Table.2: Browning index of litchi fruit as affected by postharvest treatments at different days of storage at ambient (30 ± 0.5°C) condition, 2015

Treatments	Browning Index (days after treatment)				
	2	4	6	8	10
Control (T1)	4.32^{a}	4.47^{a}	4.81^{a}	5.31^{a}	6.81^{a}
Distilled water dipping (T2)	3.90^{ab}	4.12^{a}	4.43^{a}	4.64^{b}	5.25^{b}
Oxalic acid @ 1% (T3)	4.05^{ab}	4.37^{a}	4.65^{a}	4.82^{ab}	5.00^{b}
Oxalic acid @ 3% (T4)	3.41^{bc}	4.00^{ab}	4.37^{a}	4.71^{ab}	5.00^{b}
Oxalic acid @ 5% (T5)	3.18^{c}	3.56^{b}	3.81^{b}	4.00^{c}	4.38^{c}
Grand mean	3.77	4.10	4.41	4.69	5.09
$LSD_{0.05}$	0.6752	0.5299	0.5254	0.5776	0.4494
SEM±	0.2239	0.1757	0.1742	0.1916	0.1490
CV	11.86	8.56	7.89	8.15	5.85

Means within the column followed by same letter do not differ significantly at 5% level by DMRT; Means within the column followed by same letter do not differ significantly at 5% level by DMRT; SEM = Standard Error of Mean; LSD = Least Significant Difference; CV = Coefficient of Variation; * Significant at 5% level; DAT=Days after treatment

The browning index increased as the storage duration advanced. However, the indices of the litchi fruit treated with 2 and 4 mM oxalic acid were observed significantly lower than that of the control five days after the fruit harvest (Zheng & Tian, 2006). Our present findings are in accordance with the result explained by Zheng and Tian (2006). The effect of oxalic acid on pericarp color during storage was studied by Yadav (2015) and found 10% oxalic acid promising for color retention of peel than KMS used alone or in combination with precooling on second day of storage. Pandit *et al*. (2007) also suggested in all the observations fruits treated with 1 N HCl showed much better colour followed by fruit treated with 100 ppm KMS + 1 N HCl and highest browning index was recorded in control.

The decrease in BI is a result of reduced moisture loss and maintenance of low pH which hinders the activities of enzymes. Also, chemical used in post harvest storage of fruit markedly inhibited the activities of the PPO and POD that plays important role in browning of litchi fruit (Gong & Tian, 2002). Joas et al. (2005) also reported that in the absence of any enzyme inhibition, browning occurs mainly due to dehydration of the pericarp which is consistent with the findings of Jiang and Fu (1999) and Zhang *et al.* (2001) who observed a decrease in anthocyanins in during storage.

Spoilage loss (%)

The mean data pertaining to spoilage loss of litchi in relation to different postharvest treatments during storage in the experiment 2015 is presented in Table 3. The significant variation among the treatments on spoilage loss of the fruits was noticed after the second day of storage. No spoilage loss was found in the second day of storage. On the fourth day of storage the lowest spoilage loss (4.19%) was found with oxalic acid @ 5% and the highest loss (8.24%) was recorded with control. On sixth day of storage highest spoilage loss (20.94%) was recorded with control and lowest spoilage loss (14.23%) was recorded with oxalic acid @ 3%. On eighth day of storage oxalic acid @ 5% resulted in minimum spoilage loss (21.77%) whereas distilled water dipping resulted in maximum spoilage loss (37.79%) followed by control (35.32).

Table.3: Spoilage loss (%) of litchi fruit as affected by postharvest treatments at different days of storage at ambient (30 ± 0.5°C) condition, 2015

Treatments	Spoilage loss (%) (days after treatment)				
	2	4	6	8	10
Control (T1)	0.00	8.24^{a}	20.94^{a}	35.32^{a}	66.85^{a}
Distilled water dipping (T2)	0.00	7.41^{b}	19.50^{a}	37.79^{a}	64.48^{a}
Oxalic acid @ 1% (T3)	0.00	5.94^{bc}	15.41^{b}	25.45^{b}	52.60^{b}
Oxalic acid @ 3% (T4)	0.00	5.84^{bc}	14.23^{b}	24.54^{b}	55.56^{b}
Oxalic acid @ 5% (T5)	0.00	4.91^{c}	14.26^{b}	21.77b	52.95^{b}
Grand mean	0.00	6.47	16.67	28.97	58.49
$LSD_{0.05}$	0.00	1.5896	3.2398	4.2671	3.9346
SEM±	0	0.5273	1.0747	1.4150	1.3053
CV	0.00	16.2961	12.89	9.76	4.46

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Means within the column followed by same letter do not differ significantly at 5% level by DMRT; SEM = Standard Error of Mean; LSD = Least Significant Difference; CV = Coefficient of Variation; * Significant at 5% level; DAT=Days after treatment

Similarly, on tenth day of storage maximum spoilage loss (66.85%) was found with control while fruits treated with oxalic acid @ 5% showed minimum spoilage loss which was statistically at par with fruits treated with oxalic acid @ 1% and oxalic acid @ 3%. Furthermore, the spoilage loss was in increasing irrespective of the treatments.

The result of the present study is in line with the report of Yadav (2015) as well as Pandey and Lal (2014). They found significant decrease in spoilage loss with prolongation of storage period of litchi fruit treated with 10% oxalic acid in comparison to other chemical treatment along with control. The effect of oxalic acid alone or in combination with MAP was on spoilage loss was due to creation of unfavorable (acidic, higher CO_2 and lower O_2 and high relative humidity) environment to the pathogen invasion. Also, the fruit desiccation is prevented resulting in increase in ability of fruit against disease invasion. Further, antirespirant and antisenescent capacity of some chemical lower the physiological process in harvested fruit keeping fruit in better condition. As a result, spoilage loss is minimized in storage for longer duration (Sivakumar *et al*., 2007) Likewise, Koirala (2009) reported that Bavistin 100 ppm resulted in the lowest spoilage loss (13.5%) as compared to the control treatment (16.17%).

Physiological loss in weight (%)

The effects of postharvest treatments on physiological loss in weight (PLW) expressed in percentage is given in Table 25. It revealed that there was continuous increase in physiological weight loss as the storage period prolonged. All the treatments showed similar effect on physiological weight loss on the third day of storage. The significant variation regarding physiological loss in weight was noticed on fifth days onwards in different post harvest treatments during the storage period. On the fifth day of storage highest physiological weight loss (19.63%) was observed with control followed by oxalic acid @ 3% (18.77%) while lowest weight loss (16.09%) was observed with oxalic acid @ 5%. On seventh day of storage highest weight loss (24.53%) was observed with control followed by oxalic acid @ 1% (22.87%) and minimum weight loss (18.85%) was observed with oxalic acid @ 5%. More or less similar pattern was observed up to final days of storage in which oxalic acid @ 5% resulted in minimum physiological weight loss of the litchi fruit.

Table.4: Physiological loss in weight (%) of litchi fruit as affected by postharvest treatments at different days of storage at ambient (30 ± 0.5°C) condition, 2015

Treatments	PLW (%) (days after treatment)				
	3	5	7	9	11
Control (T1)	11.26[a]	19.63[a]	24.53[a]	29.54[a]	34.67[a]
Distilled water dipping (T2)	11.18[a]	18.61[ab]	22.30[b]	25.73[b]	29.76[bc]
Oxalic acid @ 1% (T3)	11.29[a]	18.00[b]	22.87[b]	25.94[b]	30.86[b]
Oxalic acid @ 3% (T4)	11.77[a]	18.77[ab]	22.20[b]	25.73[b]	28.54[c]
Oxalic acid @ 5% (T5)	10.72[a]	16.09[c]	18.85[c]	23.55[c]	25.52[d]
Grand mean	11.24	18.22	22.15	26.13	29.87
$LSD_{0.05}$	ns	1.4722	1.1657	1.5571	1.2550
SEM±	0.4323	0.4883	0.3867	0.5165	0.4163
CV	7.68	5.36	3.49	3.95	2.78

Means within the column followed by same letter do not differ significantly at 5% level by DMRT; SEM = Standard Error of Mean; LSD = Least Significant Difference; CV = Coefficient of Variation; DAT=Days after treatment; PLW = Postharvest loss in weight

On the basis of above findings it is concluded that there is continuous increase in physiological loss in weight as the storage period advances irrespective of treatments. Our finding is in agreement with findings of Pandey and Lal (2014) and Yadav (2015) who reported a reduced loss in litchi fruit after 10% oxalic acid treatment. Pandit (2007) also reported minimum PLW (27.8%) in the fruit treated with 1N HCl as compared to control one which recorded the highest PLW during storage. This finding is also supported by Koirala (2009) who reported that KMS 125 ppm showed minimum PLW (15.27%) in comparison to other treatments. Physiological loss in weight was found significantly higher in untreated fruits than in the fruits subjected to HCl, SO_2 fumigation alone and in combination with HCl and packed in perforated LDPE packages (Virk, 2014). Lower physiological loss in weight might be attributed to the applied chemicals and acids due to their ability to retain more moisture against evaporation and respiration loss or their increase affinity

for water. PLW value might vary according to fruit cultivar type and the storage condition.

IV. CONCLUSIONS

In litchi fruits, post harvest deterioration in quality starts within 48 hours after harvest mainly due to skin browning when stored under ambient conditions. Acceptable fruit quality and longer shelf-life are important parameters for marketing of litchi fruits. From this study it was revealed that all the physiological parameters studied were significantly influenced by oxalic acid treatment. The retention of marketable and acceptable colour was varied in different treatments but the use of oxalic acid @ 5% was found superior. Among the treatment effects on physiological weight loss of litchi fruits oxalic acid @ 5% was found quite effective to minimize the loss. This treatment could reduce the PLW of litchi fruits by 9.15% as compared to control. Besides, all the treatments were capable in minimizing the PLW as compared to control. The spoilage loss was minimized when harvested fruits were treated with oxalic acid at different concentration as compared to control one. The treatment oxalic acid @ 5% reduced the decay loss by 13.9%.

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